

DOCTORAL (PHD) STUDIES COURSE UNIT DESCRIPTION

Course unit title	Scientific areas	Faculty	Institute, department
Methodological, Technical, and Technological Aspects of Systems Engineering	Informatics engineering (T 007)	Faculty of Mathematics and Informatics	Institute of Data Science and Digital Technologies

Study method	Number of credits	Study method	Number of credits
Lectures	1	Consultations	1
Individual	4	Seminars	1
Semester: spring			

Summary
The course examines the methodological, technical, and technological aspects of systems engineering adapted to the development of systems within the field of informatic engineering. Attention is drawn to different concepts of systems and the specific features in developing different types of systems. The course provides a systematic overview of issues related to the modelling, design, integration, and interoperability of complex systems, while highlighting the application of artificial intelligence methods to generate system components. Technological aspects – such as physical artificial intelligence, agent-oriented technologies, and human-machine synergy – are discussed taking into account current and predicted trends in the development and use of technologies. <i>Main topics:</i> • System, complex system, system of systems, system as a collective. • Technological, knowledge, and semiotic systems. • Systems engineering principles. • Modelling, modelling principles and paradigms, simulation. • Systems development process models. • Systems feasibility analysis, evaluation of alternatives. • User-centred paradigm for systems design. • System design as concept development and system architecture. • System cooperation and coordination. • System interoperability. • Model-Driven Architecture (MDA) / Model-Driven Engineering (MDE): layers, separation of concerns, transformation, MDA-based model transformation packages. • System synthesis, application of artificial intelligence methods. • Product line engineering. • Physical artificial intelligence. • Agent technologies. • Mobile technologies. • Human-machine synergy. <i>Practical tasks:</i> The doctoral student must create the system development documentation (selecting the engineering process, methods, modelling paradigm and language, architectural style, and technologies, and providing arguments to justify the chosen solutions). The content of the practical task is aligned with the topic of the dissertation. <i>Assessment:</i> 1. presentations at the seminar, 2. system project (documentation), 3. justification of the chosen solutions.
Main bibliography
Ch. S. Wasson (2015) System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices. 2nd ed., Wiley, 880 p., ISBN 978-1118442265

INCOSE (2023) INCOSE Systems Engineering Handbook. 5th ed., Wiley, 368 p., ISBN 978-1119814290
A. Kossiakoff, S. J. Seymour, D. A. Flanigan, S. M. Biemer (2020) Systems Engineering Principles and Practice. 3rd ed., Wiley, 688 p., ISBN 978-1119516668
OMG MDA™ Guide revision 2.0, 2014. https://www.omg.org/cgi-bin/doc?ormsc/14-06-01
L. Delligatti (2013) SysML Distilled: A Brief Guide to the Systems Modeling Language. Addison-Wesley Professional, 304 p., ISBN 978-0321927866
P. Micouin (2014) Model Based Systems Engineering: Fundamentals and Methods, Wiley-ISTE, 296 p., ISBN 978-1848214699.
A. Koudri (2025) Model Based Systems Engineering: Theoretical Foundations. Wiley, 352 p., ISBN 978-1394345076
P. Clements, L. M. Northrop (2001) Software Product Lines: Practices and Patterns. 3rd ed., Addison-Wesley Professional, 563 p., ISBN 978-0201703320
S. Rinderle-Ma, J. Mangler, D. Ritter (2024) Fundamentals of Information Systems Interoperability: Data, Services, and Processes. Springer, 300 p., ISBN 978-3031483219
P. Norvig, S. Russell (2021) Artificial Intelligence: A Modern Approach. 4th ed., Pearson, 1166 p., ISBN 978-1292401133
V. Dibia (2025) Designing Multi-Agent Systems: Principles, Patterns, and Implementation for AI Agents. 394 p., ISBN 979-8993101200
S. Ham (2025) Physical AI. ADLI Books, 387 p., ISBN 979-8266783959

Lecturer(s) (name, surname)	Science degree	Main publications
Audronė Lupeikienė	dr.	https://www.elaba.mb.vu.lt/dmsti/?aut=Audronė+Lupeikienė
Kristina Lapin	dr.	https://elaba.mb.vu.lt/mif/?aut=Kristina+Lapin
Virginijus Marcinkevičius	dr.	https://www.elaba.mb.vu.lt/dmsti/?aut=Virginijus+Marcinkevičius